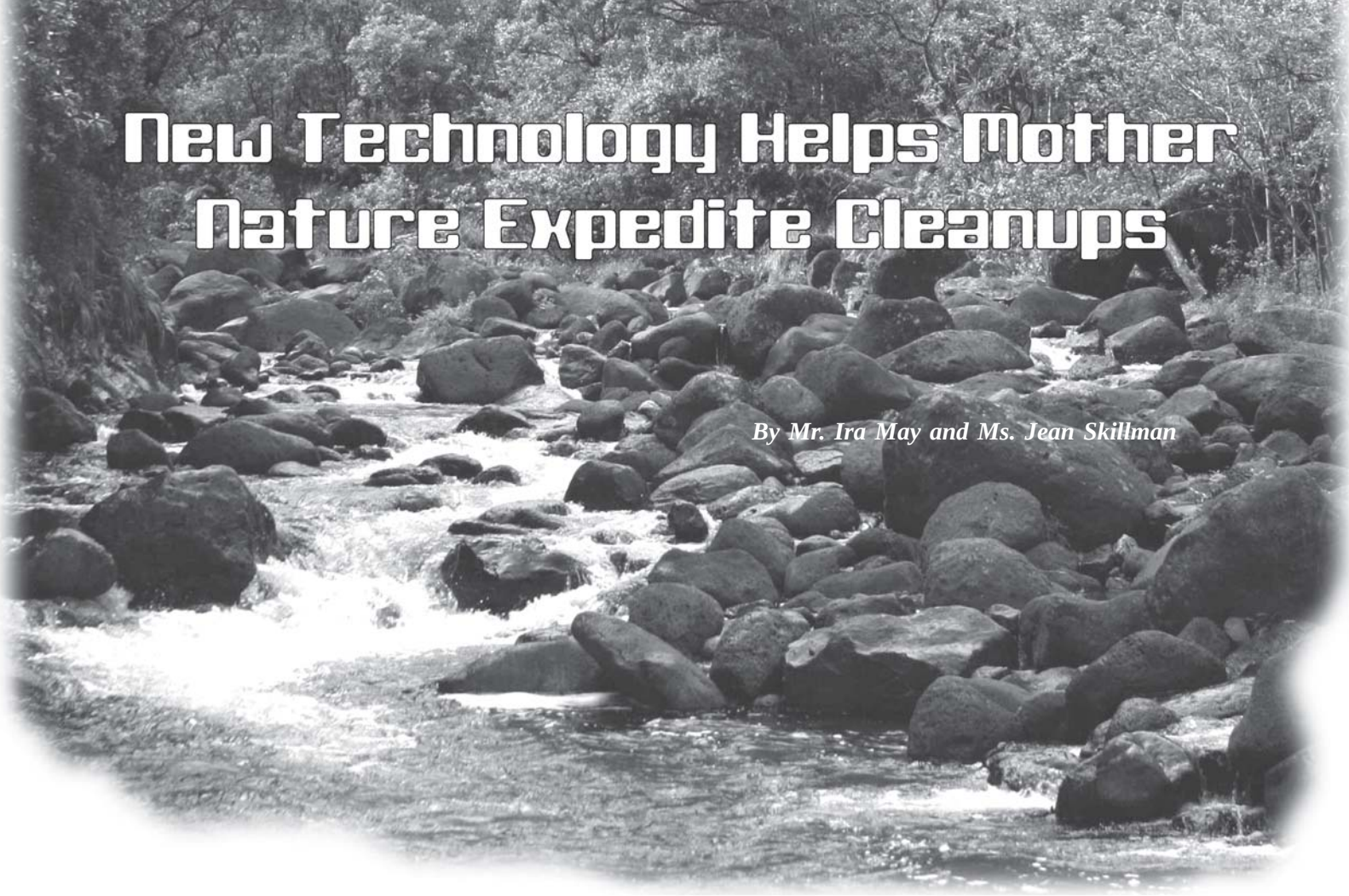
New Technology Helps Mother Nature Expedite Cleanups



By Mr. Ira May and Ms. Jean Skillman

Chlorinated solvents are the source of some of the Nation's most problematic groundwater contamination. According to a national water quality assessment by the US Geological Survey between 1992 and 1999, 70 percent of domestic and public wells contain at least one form of chlorinated solvents, nitrates, or pesticides, and 47 percent had at least two compounds. The widespread use of solvents such as dry cleaning agents, engine degreasers, and paint removers has not only polluted the Nation's groundwater but, according to the Army Environmental Security Technology Certification Program (ESTCP), represents one of the largest remediation liabilities for the Department of Defense.

The Army Challenge

Groundwater testing and cleanup is a major function of the US Army Environmental Center (USAEC). Many Army installations are fighting contamination from chlorinated solvents such as trichloroethylene (TCE), perchloroethylene (PCE), and trichloroethane (TCA) caused by dry cleaning procedures, equipment maintenance, and electronics manufacturing.

In the past, conventional treatments such as pump and treat and air sparging have been the technologies of choice for cleaning up groundwater contaminated with chlorinated solvent. Pump-and-treat remediation pulls the contaminated groundwater to the surface, removes the contaminants, and either recharges the aquifer with clean water or discharges the water into a lake or river. Most often, the systems are designed to restore the aquifer enough so that later wells can supply potable water.

Air sparging is an *in situ* (in-place) remedial technology that reduces concentrations of chlorinated solvents adsorbed onto soils and dissolved in groundwater. The technology involves the injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to a vapor. The air is then vented through the unsaturated zone. Both technologies, while reliable, are costly and time-consuming.

Tarheel Army Missile Plant

Tarheel Army Missile Plant (TAMP), a former Army-owned and contractor-operated facility in Burlington, North Carolina, recently completed a pilot program using a new in situ remediation technology that has shown promising results for better, faster, and cheaper chlorinated-solvent cleanup.

Groundwater and soil contamination were discovered at TAMP in 1993. Petroleum hydrocarbons and chlorinated volatile organic compounds from recent electronic manufacturing and 1950s missile manufacturing were detected in the soil and groundwater. A combined pump-and-treat and soil vapor extraction/air-sparging system was installed to remediate the soil and groundwater. The approach was effective for the treatment of the petroleum hydrocarbons, but the elevated levels of the chlorinated solvents persisted.

A Solutions-IES field services manager inspects the installation of EOS injection well vaults. The wells are tied together with double-walled PVC pipes, allowing injections and extractions in alternate wells.

The US Army reached an agreement with the state of North Carolina to reduce the chlorinated solvent contamination at the TAMP source by 50 percent within three years to meet interim regulatory requirements. Eight different remedial options were evaluated by the USAEC before they selected an in situ bioremediation technique using Emulsified Oil Substrate (EOS®) from Solutions-IES, Incorporated. The food grade soybean oil solution seemed the best choice to stimulate the reductive dechlorination process and remediate the contaminated groundwater. The EOS technology seemed to be the right fit for the slow-moving aquifer found in this geology.

Reductive Dechlorination

During the dechlorination process, diluted EOS is injected into the aquifer and followed with chase water to distribute and immobilize the oil droplets. Once in the subsurface, the food grade substrates biodegrade, consuming dissolved oxygen and releasing hydrogen to stimulate reductive dechlorination. By using a natural soy-based product, we are in essence helping Mother Nature expedite the process that would normally clean contamination from the soil and water. The EOS acts as a food for the bacteria by providing energy that stimulates the breakdown of contaminants. And extensive laboratory studies and field demonstrations have proven that EOS can stimulate complete reductive dechlorination of TCE, PCE, and TCA to nontoxic ethene and/or ethane with just one treatment. The chemicals added during in situ bioremediation are normally short-term, but the EOS has a much longer effect.

Pilot Test Design

The pilot test of the EOS process was implemented in July and August of 2004 to treat a 100-square-foot area that had relatively high TCE concentrations. Site conditions posed some unique technical challenges, including relatively low-yielding soil and saprolite, the need to run all piping below grade, and the requirement to design around an underground pedestrian tunnel in the test area. The final site included eight wells manifolded together into four well pairs. The injection was completed in two steps. During the first step, the diluted emulsion was gravity fed into half of the wells and chased with groundwater supplied from the other paired wells. After several weeks, the system was reversed and EOS was injected into the other half of the four paired wells. Visual inspection of the wells showed that the milky white EOS emulsion was effectively distributed throughout the low-permeability aquifer.

A Solutions-IES employee excavates a trench for the installation of a custom-engineered, below-grade EOS recirculation system.

effective, the Army has already reached the interim groundwater remediation goals for the site. Additional sampling is planned to confirm the long-term effectiveness of this approach.

TCE and its breakdown products are some of the biggest problems facing the Army and industry today. The best idea is to move away from technologies that only stop the contamination and move toward the technologies, like in situ remediation, that actually clean the water in the ground.

For more information on this and other environmental programs, see the USAEC Web site at *<http://aec.army.mil>*.

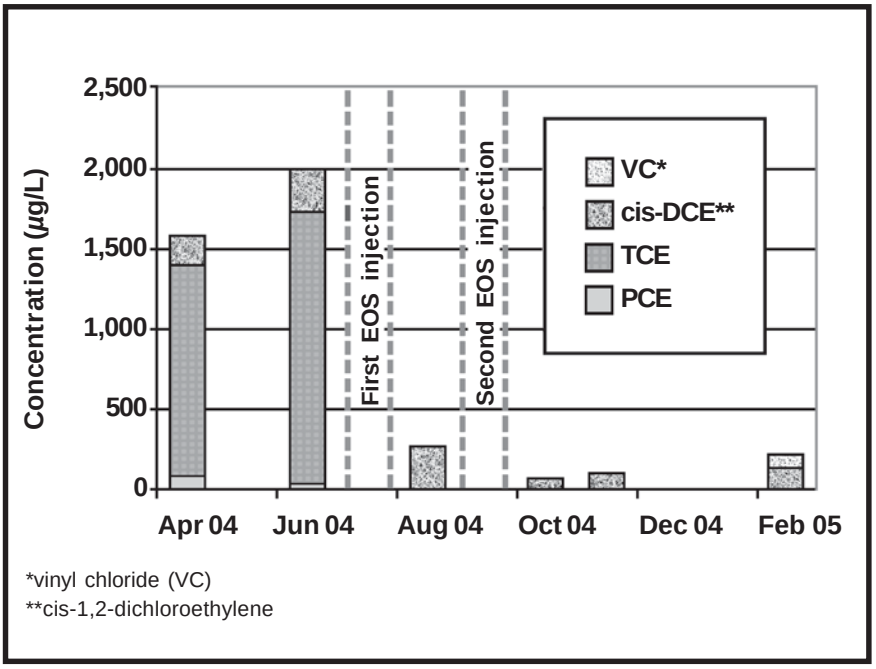
Mr. May is a senior geologist in the Cleanup Division of USAEC. He has been with USAEC since 1985 and has been involved in more than twenty major installation projects involving installation restoration and base closure activities. He is presently running the Army Groundwater Extraction and Treatment Effectiveness Review Program. Mr. May studied geology at the Hebrew University of Jerusalem and Johns Hopkins University and did graduate work at the University of Delaware in trace metal geochemistry.

Ms. Skillman is a public affairs representative for USAEC. She holds a bachelor's degree in communications from the University of Maryland and served twelve years on active duty as a US Navy journalist.

Monitoring the Results

Groundwater samples were collected from existing wells in the pilot test area before and after injection to evaluate the treatment effectiveness. Within weeks after injection, anaerobic conditions in the treatment zone were effectively established. Soon thereafter, TCE concentrations decreased by 99 percent and have remained low. Within five months, degradation daughter products were detected, confirming on-going biodegradation.

The pilot test was originally designed to treat the plume source and evaluate whether this approach should be expanded to treat the entire plume. Because the treatment has been so



This graphic illustrates the rapid decrease in chlorinated volatile organic compounds in the pilot test area following EOS injection.